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Impact of carwash discharge on stormwater quality (Toulouse, France)

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Abstract The contribution of discharge from carwashes to pollutant levels in stormwater was evaluated. Five carwashes and two outlets in the city of Toulouse (France) were selected. Water samples were collected from December 2006 to December 2007. Concentrations and loadings of classical water quality parameters (conductivity, pH, turbidity, chemical oxygen demand, nitrogen, phosphorus, ammonium, nitrate, suspended solid and volatile suspended solid) and five groups of organic compounds (polycyclic aromatic hydrocarbons, polychlorinated biphenyls, lauryl alkyl benzene sulphonates, methyl tert-butyl ether and total hydrocarbons) were determined. The results suggest that the wastewater derived from carwashes was negligible compared to the volume and flow rates within the stormwater network. However, high concentrations of polycyclic aromatic hydrocarbons, phosphorus and lauryl alkyl benzene sulphonates in liquid waste from carwashes, and the impact of these pollutants on stormwater quality could not be neglected.
Keywords Organic pollutants; pollutant loading; separated sewer system; urban stormwater

INTRODUCTION

Stormwater, is known to be an important source of received water pollution in many municipalities (Clark et al., 1971). Pollution from urban runoff water comprises many sources, including heavy and light industry, road runoff, illicit connections and illegal dumping (Walker et al., 1999). The European Water Directive (European Commission, 2000), whose aim is to better ecological and environmental quality, has mandated water quality assessment of a wide range of organic pollutants in addition to classical water quality parameters.

Specific sources for several chemical classes are listed below, along with their observed concentration in urban runoff (Table 1). Organic micropollutants in the environment originate from both domestic and industrial anthropogenic activities and are transferred to the atmosphere, soil, and surface water via specific point sources or more diffuse inputs. The main sources of polycyclic aromatic hydrocarbons (PAHs) originate from pyrolysis of organic matter at high temperature (Moilleron et al., 2006). Polychlorinated biphenyls (PCBs) have been used extensively in many industrial applications, including in fire-resistant transformers and insulating condensers (Waid, 1996). PCBs have contaminated the environment due to inconvenient storage practices, industrial incidents or handling oversights. Urban surfaces can receive deposits of PAHs and PCBs from different sources such as car traffic, industries, waste incinerators, and domestic heating via both atmospheric transport and local activity (Cailleaud et al., 2007). Methyl *tert*-butyl ether (MTBE) is a volatile organic compound produced from natural gas. It is commonly selected by petroleum refiners and distributors to aid the oxygenation of fuel to reduce carbon monoxide emissions. It is introduced to the environment by leaking petroleum storage tanks, urban runoff, and motorised watercraft (Achten et al., 2001). Linear alkylbenzene sulphonates (LAS) are the most important synthetic anionic surface active agents, and they are the principal constituents of commercial detergents used for institutional cleaning and industrial purposes. LAS are significant environmental pollutants as the bio-degradation of these compounds consumes bio-available oxygen. LAS are not only toxic, but also contribute to the permeation of other pollutants into aquatic animals (Sanderson et al., 2006).

The case of Toulouse, France is particularly interesting because the town has a separated sewer system where organic compounds in the wastewater system cannot mix with the stormwater system (Xaumier et al., 2004). The stormwater sewer discharges into the Garonne River, whereas wastewater is routed to the wastewater treatment plant. However, water in the stormwater system comes not only from roof and road runoff but also from carwash discharges after a standard, on-site pre-treatment process. Previous studies have questioned the efficiency of these pre-treatment processes. The aim of this work was to analyse the wastewater from carwashes upstream of the stormwater network to evaluate the impact of this source of pollution on the quality of stormwater.

Table 1. Reported concentrations of organic pollutants in water reservoirs

Organic pollutants	Water type	n	Origin	Concentrations				References
				Min.	Max.	Mean	Median	
PCBs (µg/L)								
PCBs (Σ12)	River water	52	France	0.020	0.990	0.115	-	(Chevreuil et al., 1990)
	Potable water	-		0.025	0.220	0.079	-	
	Raw wastewater	-		0.380	1.300	0.650	-	
	Treated wastewater	-		0.150	0.390	0.280	-	
PCBs (Σ7)	Raw wastewater	5	France	0.020	0.036	0.029	0.031	(Blanchard et al., 2001)
PCBs (Σ7)	Raw wastewater	20	Greece	0.470	1.800	1.000	1.000	(Katsoyiannis et al., 2004)
	Primary effluent	20		0.320	1.700	0.631	0.570	
	Secondary effluent	20		0.130	0.390	0.250	0.250	
PCBs (Σ12)	Runoff water	89	Switzerland	$0.11\ 10^{-3}$	0.403	-	-	(Rossi et al. 2004)
PCBs (Σ13)	Sea water	10	Italy	$0.45.10^{-3}$	$2.1.10^{-3}$	-	-	(Manodori et al., 2006)
PAHs (µg/L)								
PAHs (Σ11)	Surface water	6	France	4.10^{-3}	0.036	0.020	-	(Fernandes et al., 1997)
PAHs (Σ15)	Sea water	-	UK	1.10^{-3}	24.821	1.002	-	(Law et al., 1997)
PAHs (-)	Runoff water	35	France	0.011	0.474	0.096	0.074	(Legret et al., 1999)
PAHs (Σ16)	Raw wastewater	4	France	1.277	3.240	1.998	1.737	(Blanchard et al., 2001)
PAHs (Σ15)	Underground water	1	Germany	-	-	$9.4.10^{-3}$	-	(Popp et al., 2001)
	Surface water	1		-	-	0.280	-	
	Rainwater	1		-	-	0.079	-	
PAHs (Σ14)	Runoff water	33	France	-	-	0.149	0.063	(Moteley-Massei et al., 2006)
PAHs (Σ12)	Surface water	27	Spain	2.10^{-3}	0.336	0.042	0.013	(Olivella et al., 2006)
PAHs (Σ15)	Rainwater	6	France	0.031	0.105	0.060	0.061	(Bourdat-Deschamps et al., 2007)
PAHs (Σ11)	Surface water	10	France	0.123	0.407	0.227	0.211	(Cailleaud et al., 2007)
Total hydrocarbons (mg/L)								
TH	Runoff water	56	France	0.1	4.9	2.3	-	(Daligault et al ., 1999)
TH	Runoff water	44	France	0.14	4.2	1.2	0.86	(Legret et al., 1999)
TH	Runoff water	-	Europe	0.04	25.9	1.9	-	(Barraud et al., 2006)

LAS (µg/L)								
LAS (Σ C_{10}-C_{13})	Raw wastewater Treated wastewater	24 24	-	3400 21	10700 290	6329 68	5850 56	(Crescenzi et al., 1996)
LAS (Σ C_{10}-C_{13})	River water downstream a WWTP	8	UK	5	416	147	106	(Fox et al., 2000)
LAS (Σ C_{10}-C_{13})	Raw wastewater Treated wastewater Seawater	16 16 -	Spain	104 11 0.67	1920 595 26	837 90 -	- - -	(Gonzalez et al., 2004)
LAS (Σ C_{10}-C_{13})	Seawater	3	Spain	11.7	64.4	22.7	17.7	(Lara-Martin et al, 2006)
MTBE (µg/L)								
MTBE	Rainwater Runoff water	35 12	Germany	<0.010 0.030	0.085 1.174	0.032 0.204	0.024 0.114	(Achten et al, 2001)
MTBE	Potable water River water	5 3	Italy	0.05 0.10	0.40 0.15	0.17 0.12	0.08 0.10	(Piazza et al., 2001)
MTBE	Potable water	83	Germany	0.017	0.712	0.089	0.038	(Kolb et al., 2006)

MATERIALS AND METHODS

Sampling sites

Three carwashes were selected in Toulouse with the help of Veolia Water operators: Site 1 was a manual wash station that only serviced trucks; Site 2 was a self-service, high-pressure water jet carwash that serviced cars and motorcycles; Site 3 was located in a petrol station that offered a self-service high-pressure water jet and washing roller brushes. These three sites discharged wastewater into the stormwater network downstream of a pre-treatment system composed of a scrubber and an oil separator.

The two main stormwater outlets of Toulouse were selected to evaluate the stormwater quality. The "Boulevards" outlet corresponds to an urbanised catchment area of 439 hectares. The "Mirail" outlet drains water from a more rural catchment area of 1428 hectares.

Sampling method

Samples were collected and analysed between December 2006 and December 2007. Five 15 L samples were collected manually at each carwash from a pipe at the pre-treatment process exit, and they were homogenised to obtain a representative sample. Two automatic samplers were used to sample the two stormwater outlets during two dry events and eight rainy events over 24 hours. Amber glass bottles were filled to 1 L and stored at -25 °C until analysis.

Analysis

Routine classical parameters, including conductivity, pH and turbidity of total water samples were measured. Commercial tests (Spectroquant ®, Merck) were used to analyse chemical oxygen demand (COD), nitrogen (tot-N) and phosphorus (tot-P) on raw samples and to determine ammonium ($N\text{-}NH_4$) and nitrate ($N\text{-}NO_3$) in filtered samples. Suspended solid (SS) and volatile suspended solid (VSS) were investigated by filtration using NF-T90-105-1 and NF-T90-029, respectively.

Trace organic compounds were also analysed to complete the common characterisation procedures. Polycyclic aromatic hydrocarbons (PAHs) were analysed using liquid-liquid extraction and gas spectrometry with fluorescence detection according to NF EN ISO 17993. The 16 PAHs from the Environmental Protection Agency were measured: Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene. The limit of quantification (LOQ) for individual PAHs was 0.01 µg/L. Polychlorinated biphenyls (PCBs) were analysed with gas chromatography-mass spectrometry after a liquid-liquid extraction. Seven PCB congeners (from three to seven chlorines) with IUPAC numbers 28, 52, 101, 118, 138, 153, 180 were analysed. The limit of quantification for individual PCBs was 0.05 µg/L. Methyl *tert*-butyl ether (MTBE) was analysed with gas chromatography-mass spectrometry after head-space extraction with a limit of quantification of 1 µg/L. Total hydrocarbons (TH) were analysed using liquid-liquid extraction and gas chromatography equipped with a flame ionisation detector according to NF EN ISO 9377-2; the limit of quantification was 0.10 mg/L. Lauryl Alkyl Benzene Sulphonates (LAS) were quantified with liquid-liquid extraction and liquid chromatography coupled with diode array detector; the limit of quantification for the sum C10-C13 was 1 µg/L.

RESULTS AND DISCUSSION

Pollutant concentrations in carwash samples

For the five samples collected at each carwash station, the minimum, maximum, mean, median and standard deviation values were calculated and are reported in Table 2. Values less than the quantification limit were considered to be zero for statistical calculations.

Table 2. Water quality statistics determined for the three investigated carwashes. *Environmental standards noted on the discharge licences of the three carwashes **Environmental standards decided by French legislation for surface water (Decree April 20th, 2005)

	Units	n	Min.	Max.	Mean	Median	Standard deviation	Environmental standards
Site 1: truck carwash								
COD	mg /L	5	539	1 506	949	654	462	125*
Tot-P	mg/L	5	16.5	53.2	35.5	29.6	15.6	10*
Tot-N	mg/L	5	8	19	12	11	4	30*
NH_4^+	mgN/L	5	0.1	1.9	0.6	0.1	0.8	-
NO_3^-	mgN/L	5	0.5	1.6	1.1	1.0	0.4	-
pH	-	5	4.9	6.9	6.0	5.8	0.8	-
Conductivity	µS/cm	5	687	8450	4357	3849	2884	-
Turbidity	NTU	5	60	152	126	133	38	-
SS	mg/L	5	46	518	302	236	208	35*
VSS	% SS	5	10	40	22	13	14	-
Σ PAHs (16)	µg/L	5	1.002	2.740	1.778	1.726	0.638	-
Anthracene	µg/L	5	<LOQ	0.037	0.014	0.016	0.015	0.1**
Naphthalene	µg/L	5	0.290	0.710	0.524	0.550	0.165	2.4**
Benzo(a)pyrene	µg/L	5	<LOQ	0.140	0.048	0.025	0.055	0.05**
Benzo(b)fluoranthene	µg/L	5	<LOQ	0.150	0.054	0.034	0.058	0.05**
Σ PCBs (7)	µg/L	5	0.17	2.26	1.16	0.93	0.82	0.001**
Σ LAS	mg/L	5	<LOQ	0.053	0.014	<LOQ	0,023	-
MTBE	µg/L	5	<LOQ	12.0	<0.001 2.4	0.023 <LOQ	5.4	-
TH	mg/L	5	<LOQ	0.92	0.56	0.58	0.34	10*
Site 2: self-service carwash								
COD	mg/L	5	80	421	239	185	145	125*
Tot-P	mg/L	5	4.0	99	28	5.4	41	10*
Tot-N	mg/L	5	6	14	9	8	3	30*
NH_{4+} (filtered)	mgN/L	5	0.1	0.5	0.3	0.1	0.2	-
NO_3^- (filtered)	mgN/L	5	0.5	1.1	0.7	0.7	0.2	-
pH	-	5	8.6	9.6	9.1	9.2	0.4	-
Conductivity	µS/cm	5	562	2880	1457	1273	958	-
Turbidity	NTU	5	42	203	100	80	68	-
SS	mg/L	5	35	223	130	124	67	35*
VSS	% SS	5	24	89	50	47	26	-
Σ PAHs (16)	µg/L	5	0.016	0.826	0.372	0.361	0.318	-
Anthracene	µg/L	5	<LOQ	<LOQ	<LOQ	<LOQ	-	0.1**
Naphthalene	µg/L	5	<LOQ	0.210	0.079	0.075	0.087	2.4**
Benzo(a)pyrene	µg/L	5	<LOQ	0.038	0.010	<LOQ	0.016	0.05**
Benzo(b)fluoranthene	µg/L	5	<LOQ	0.041	0.013	0.010	0.017	0.05**
Σ PCBs (7)	µg/L	5	0.01	1.21	0.41	0.11	0.52	0.001**
Σ LAS	mg/L	5	8.10	64.00	20.12	9.80	24.54	-
MTBE	µg/L	5	<LOQ	24,542 1.5	9,800 0.3	<LOQ	0.7	-
TH	mg/L	5	<LOQ	0.12	0.02	<LOQ	0.05	10*

Site 3: petrol station carwash								
COD	mg/L	5	144	301	227	235	59	125*
Tot-P	mg/L	5	0.3	0.8	0.5	0.5	0.2	10*
Tot-N	mg/L	5	6	13	10	9	3	30*
NH_4^+	mgN/L	5	0.1	0.5	0.2	0.1	0.2	-
NO_3^-	mgN/L	5	0.1	0.4	0.2	0.2	0.1	-
pH	-	5	6.7	7.5	7.0	7.1	0.3	-
Conductivity	µS/cm	5	254	638	490	523	153	-
Turbidity	NTU	5	23	43	32	27	9	-
SS	mg/L	5	13	90	45	51	32	35*
VSS	% SS	5	26	98	77	85	39	-
Σ PAHs (16)	µg/L	5	0.101	0.731	0.319	0.170	0.276	-
Anthracene	µg/L	5	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.1**
Naphthalene	µg/L	5	<LOQ	0.110	0.058	0.046	0.051	2.4**
Benzo(a)pyrene	µg/L	5	<LOQ	0.021	0.004	<LOQ	0.009	0.05**
Benzo(b)fluoranthene	µg/L	5	<LOQ	0.030	0.006	<LOQ	0.013	0.05**
Σ PCBs (7)	µg/L	5	0.05	0.45	0.19	0.06	0.19	0.001**
Σ LAS	mg/L	5	0.046	3.000	0.719	0.086	1.282	-
MTBE	µg/L	5	<LOQ	1.3	0.3	<LOQ	0.6	-
TH	mg/L	5	<LOQ	0.24	0.09	0.11	0.10	10*

Pollutant concentrations in outlets samples

Mean and standard deviation values were calculated from the ten values for each parameter measured at the two outlets (Table 3). Values less than the quantification limit were considered to be zero for statistical calculations.

Table 3. Water quality statistics of the two investigated outlets. *Environmental standards noted on the discharge licences of the three carwashes **Environmental standards decided by French legislation for surface water (Decree April 20th, 2005)

	Units	n	Min.	Max.	Mean	Median	Standard deviation	Environmental standards
Outlet 1: Boulevard								
COD	mg /L	10	31	156	80	67	43	125*
Tot-P	mg/L	10	0.6	1.2	0.8	0.7	0.2	10*
Tot-N	mg/L	10	6	54	18	10	19	30*
NH_4^+	mgN/L	10	0.1	4.9	1.0	0.1	2.0	-
NO_3^-	mgN/L	10	2.7	6.5	4.1	4.0	1.1	-
pH	-	10	7.1	8.3	7.5	7.4	0.3	-
Conductivity	µS/cm	10	202	620	398	398	122	-
Turbidity	NTU	10	3.1	21.0	12.0	11.8	4.4	-
SS	mg/L	10	7.7	50.2	30.1	35.8	17.4	35*
VSS	% SS	10	20.5	94.7	56.2	48.6	30.4	-
Σ PAHs (16)	µg/L	10	<LOQ	0.067	<LOQ	<LOQ	-	-
Anthracene	µg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	0.1**
Naphthalene	µg/L	10	<LOQ	0.018	<LOQ	<LOQ	-	2.4**
Benzo(a)pyrene	µg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	0.05**
Benzo(b)fluoranthene	µg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	0.05**
Σ PCBs (7)	µg/L	10	0.06	0.51	0.28	0.30		0.001**
Σ LAS	µg/L	10	43	590	252	87		-
MTBE	µg/L	10	<LOQ	1.9	0.2	<LOQ		-
TH	mg/L	10	<LOQ	1.5	0.2	0		10*

Outlet 2: Mirail								
COD	mg/L	10	29	146	61	46	37	125*
Tot-P	mg/L	80	0.1	0.2	0.2	0.2	0.0	10*
Tot-N	mg/L	10	4.0	38	14	10	13	30*
NH_4^+	mgN/L	10	0.1	1.0	0.2	0.1	0.3	-
NO_3^-	mgN/L	10	2.3	4.5	3.1	2.7	0.8	-
pH	-	10	7.1	8.1	7.5	7.4	0.3	-
Conductivity	µS/cm	10	235	489	317	303	81	-
Turbidity	NTU	10	4.0	22.1	12.3	11.3	6.1	-
SS	mg/L	10	7.6	46.5	26.9	32.0	14.5	35*
VSS	% SS	10	25.8	80.9	50.7	46.3	18.8	-
Σ PAHs (16)	µg/L	10	<LOQ	0.15	<LOQ	<LOQ	-	-
Anthracene	µg/L	80	<LOQ	<LOQ	<LOQ	<LOQ	-	0.1**
Naphthalene	µg/L	10	<LOQ	0.14	<LOQ	<LOQ	-	2.4**
Benzo(a)pyrene	µg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	0.05**
Benzo(b)fluoranthene	µg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	0.05**
Σ PCBs (7)	µg/L	10	<LOQ	0.56	0.27	0.27	0.1	0.001**
Σ LAS	µg/L	10	6.2	920	245	30	56	-
MTBE	µg/L	80	<LOQ	30	3.3	<LOQ	2.5	-
TH	mg/L	10	<LOQ	<LOQ	<LOQ	<LOQ	-	10*

The pH and Tot-P levels measured at the two outlets were lower than levels suggested by the carwash licences. Conductivity values were highly variable throughout the year and ranged between 200 and 600 µS/cm. Two events led to high concentrations in COD and Tot-N. Half of the samples had SS values higher than the threshold value.

Globally, trace organic compound levels measured in this study were consistent with previous reports (Cailleaud et al., 2007; Mateley-Massei et al., 2006; Xaumier et al., 2004; Achten et al., 2001; Piazza et al., 2001; Legret et al., 1999). TH, MTBE and PAH levels were quite low and difficult to quantify. PCBs and LAS were detectable in every sample. These levels were similar in magnitude to that found in runoff water (Rossi et al., 2004; Blanchard et al., 2001). Concentrations of PAHs, PCBs, MTBE and LAS were higher at the Mirail outlet than at the Boulevard outlet.

Pollutants loads

The carwashes consumed water at rates of 5 226 m^3/year, 3 800 m^3/year, 1 372 m^3/year for sites 1, 2 and 3, respectively. Water flow rates at the outlets are presented in Table 4. These data indicate that the year-averaged hourly water consumption rate of a single carwash was less than 0.6 m^3/h. This flow is negligible compared to the flow at the outlet during a rain event, which can reach 6507 m^3/h.

Table 4. Statistical data on flows (m^3/h) of the two outlets over the ten sampling periods

		n	Minimum	Maximum	Mean	Median	Standard deviation
"Boulevards" outlet	Dry period	2	26	201	61	61	9
	Rainy period	8	14	6 507	194	164	365
"Mirail" outlet	Dry period	2	7	75	36	36	2
	Rainy period	8	6	418	66	72	38

The yearly pollutant loading for carwashes was calculated according to the equation presented in Equation 1, which gives a mass of pollutant per year.

Equation 1. Yearly pollutant loadings for a carwash (j). $x_{p,j}$ is the average load of a pollutant (p) over a year for the carwash (j). $x_{i,p,j}$ is the average concentration of a pollutant (p) for the sampling event (i) for the carwash (j). y_j is the water consumption of the carwash (j) for one year.

$$\boxed{x_{p,j} = \frac{1}{n}\sum_{i=1}^{n} x_{i,p,j} \times y_j}$$

The yearly pollutant loadings for each parameter measured at the outlets were calculated for 2 dry events and 8 rainy events according to Equation 2. Values less than the quantification limit were considered to be zero for the calculation.

Equation 2. Yearly pollutant loading for an outlet (o). $L_{p,o}$ is the load of a pollutant (p) over one year for the outlet (o). $\sum_{d=1}^{n} L_{p,o,d}$ is the load of a pollutant (p) for the outlet (o) in dry periods (d) (in this case n=2). $\sum_{r=1}^{m} L_{p,o,r}$ is the load of a pollutant (p) for the outlet (o) in rainy periods (r) (in this case m=8). $x_{p,o,d}$ represents the concentration of the pollutant (p) at the outlet (o) during the dry periods studied (d). $f_{o,d}$ is the water flow at the outlet (o) during the dry periods studied (d). t is the duration of dry periods over a year. $x_{p,o,r}$ represents the concentration of the pollutant (p) at the outlet (o) during the rainy period (r). $f_{o,r}$ is the water flow rate at the outlet (o) during the rainy period (r). t_r is the duration of the rainy period (r). w is the yearly precipitation.

$$L_{p,o} = \sum_{d=1}^{n} L_{p,o,d} + \sum_{r=1}^{m} L_{p,o,r}$$

$$\text{with } \sum_{d=1}^{n} L_{p,o,d} = \frac{1}{n}\sum_{d=1}^{n}\left(x_{p,o,d} \times f_{o,d}\right)\times t$$

$$\text{and } \sum_{r=1}^{m} L_{p,o,r} = \frac{1}{m}\sum_{r=1}^{m}\frac{x_{p,o,r} \times f_{o,r} \times t_{o,r}}{w_{o,r}} \times w$$

Table 5 presents the calculated yearly pollutant loadings.

Table 5. Calculated pollutant loads for the three carwashes and the two outlets over a year

Parameter	unit	**Site 1 Truck carwash**	**Site 2 Self-service carwash**	**Site 3 Petrol station carwash**	**Outlet 1 Boulevard**	**Outlet 2 Mirail**
COD	kg/year	4962	907	311	100 612	32 538
Tot-P	kg/year	186	106	0.7	1 099	65
Tot-N	kg/year	65	33	13	23 961	7 765
NH4-N	kg/year	3	1	0.3	1 185	197
NO3-N	kg/year	6	3	0,3	4 457	1 555
SS	kg/year	1578	419	61	40 656	9 494
VSS	kg/year	234	142	39	15 692	3 291
ΣPAHs (16)	g/year	9.3	1.4	0.44	15	-
ΣPCBs (7)	g/year	6.1	1.6	0.26	322	64
DEHP	g/year	211	27.8	7.88	14 359	10 186
ΣLAS (4)	g/year	73	76456	986	324 142	52 992
HT	g/year	2916	91	126	-	-
MTBE	g/year	13	1.1	0.36	416	5 271

Impact of carwashes on stormwater quality
As carwashes are allowed to drain their liquid waste into the stormwater system, it is interesting to compare loads from carwashes to the total pollution loads at outlets.

An inventory of the organisations that own discharges licences was determined for each catchment area: 22 licenced establishments contributed to the "Boulevards" outlet, compared to 8 for the "Mirail" outlet. These included residences, car parks, garage/workshop. We decided to represent all carwash organisations by one of the three carwashes studied. The configuration finally chosen for the two outlets studied was two self-service carwashes, two petrol station carwashes and one truck carwash. Figures 1 and 2 compare the pollutant loads derived from this configuration and that calculated for the two outlets.

Figure 1. Contribution of carwashes to pollution loading at the "Boulevards" outlet

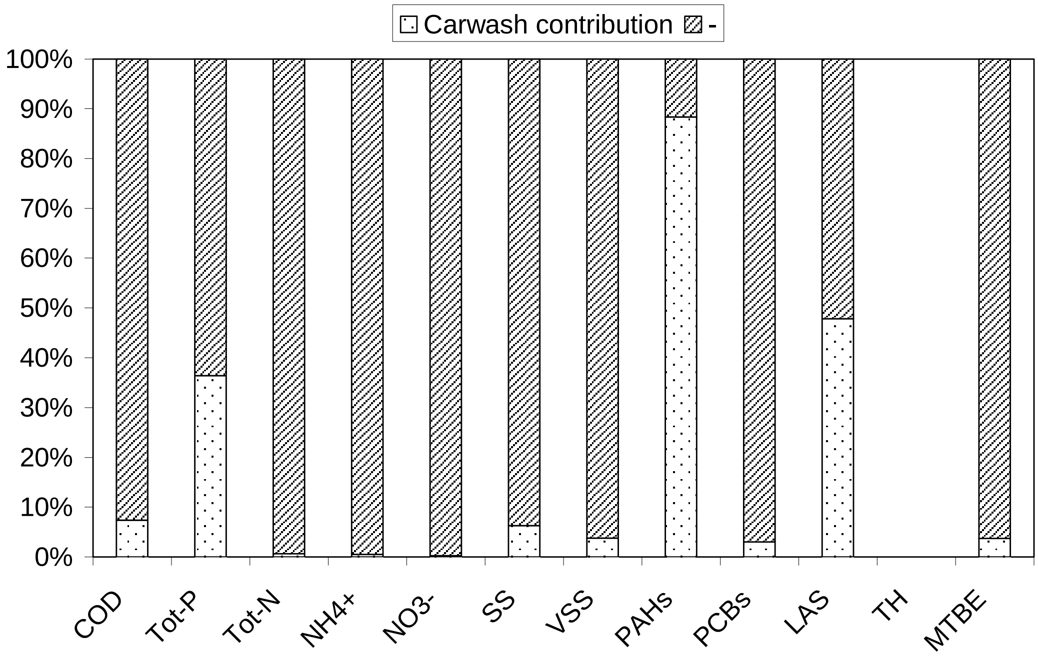
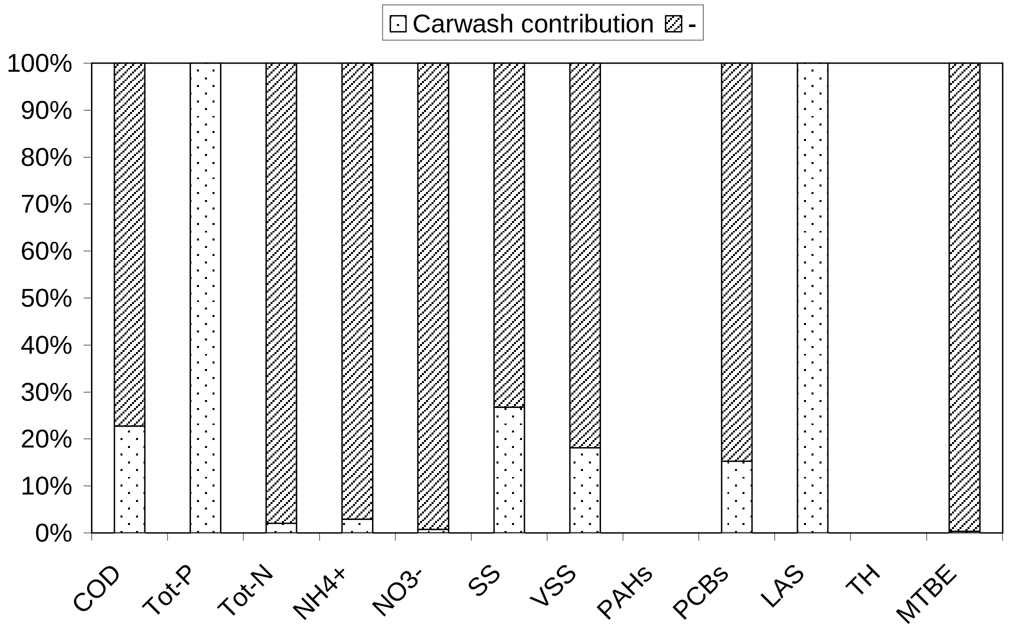


Figure 2. Contribution of carwashes to pollution loadings at the "Mirail" outlet



The results indicate that the pollution derived from carwashes is variable between the outlets studied; the "Mirail" outlet seems to be more sensitive to carwash pollution. For both outlets, the pollution parameters that were broadly attributable to carwash stations were LAS, phosphorus and PAHs. During dry periods, the bulk of these pollutants appeared to derive from carwash stations.

CONCLUSIONS

This study evaluated the impact of carwash discharge on the quality of stormwater in a city equipped with separated stormwater and wastewater sewer systems. We screened classical pollutant parameters and organic pollutants in carwash wastewater and outlet runoff. The results suggest that, for at least one of the three carwashes studied, the measured pollutant concentrations in carwash discharge was more similar to the levels found in wastewater than in runoff stormwater. We also compared the pollutant loadings of carwash discharge to that of two stormwater outlets. Water consumption of carwashes was negligible compared to the volume and flow rate of the stormwater system. However, high concentrations of total phosphorus, PAHs and LAS were identified as contaminants in liquid waste from carwashes. The negative impact of carwash discharge in stormwater sewers was identified, and it is completely dependent on the number of carwashes.

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